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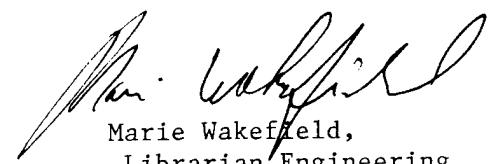


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FINAL REPORT  
EXECUTIVE SUMMARY  
INCREMENT A AND B STUDY  
AT  
ABERDEEN PROVING GROUNDS, MARYLAND

Prepared for:

Department of the Army  
Norfolk District, Corps of Engineers  
Norfolk, Virginia 23510

Under Contract No. DACA-65-84-C-0105

March 1988

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W.O. #0335-72-01/02

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## SECTION 1

### EXECUTIVE SUMMARY

#### 1.1 INTRODUCTION

This report presents the results of the Energy Engineering Analysis Program conducted by Roy F. Weston, Inc. at the Aberdeen and Edgewood Areas of Aberdeen Proving Grounds under Contract No. DACA-65-84-C-0105. The study includes identification and evaluation of specific energy conservation opportunities that are applicable to the 44 buildings at Aberdeen and Edgewood.

The Increments of Work to be provided as stated in the Scope of Work:

Increment A - Projects involving modifying, improving or retrofitting existing buildings to make them more energy efficient.

Increment B - Energy conservation investigations of utilities and energy distribution systems, and energy monitoring and control systems (EMCS).

The study involved field surveying the various buildings to find out the present operating conditions and schedules, and to identify energy conservation opportunities that may be applicable. Detailed calculations were performed to evaluate the opportunities and package them into QRIP/PECIP projects.

#### 1.2 HISTORICAL ENERGY CONSUMPTION

The annual fuel consumption at Aberdeen and Edgewood for FY 1985 (October 1984 to September 1985) was:

- Annual Electric Consumption at Aberdeen - 86,823,988 kWh
- Annual Electric Consumption at Edgewood - 60,406,319 kWh
- Total Electric Consumption at Base - 147,230,307 kWh
- Annual Fuel Oil Consumption at Aberdeen - 5,284,904 Gallons
- Annual Fuel Oil Consumption at Edgewood - 7,649,696 Gallons

- Total Fuel Oil Consumption at Base - 12,934,600 Gallons

The average fuel oil cost for FY 1985 was 0.95 per gallon.

The latest electric consumption and cost data available for the Aberdeen and Edgewood areas is for the year beginning in October of 1984 and continuing through September of 1985. Electricity is supplied to the base by four utility companies - Baltimore Gas and Electric Company, Delmarva Power Company, Conowingo Power Company and Choptank Electric Cooperative, Inc. In FY 1985 a total of 147,230,307 kWh of electricity was consumed at Aberdeen and Edgewood, costing \$7,398,316.22. This results in an average electric cost of \$0.05/kWh which was used in this report.

For FY 1984 (October 1983 to September 1984) the total consumption of fuel oil and electricity was:

- Annual Electric Consumption at Aberdeen - 82,884,291 kWh
- Annual Electric Consumption at Edgewood - 58,579,513 kWh
- Total Electric Consumption at Base - 141,463,804 kWh
- Annual Fuel Oil Consumption at Aberdeen - 6,319,126 Gallons
- Annual Fuel Oil Consumption at Edgewood - 8,953,330 Gallons
- Total Fuel Oil Consumption at Base - 15,272,456 Gallons

Fuel oil consumption for FY 1985 was 18.1% lower than for FY 1984 and electric consumption for FY 1985 was 4.1% higher than for FY 1984.

In comparison fuel oil consumption for FY 1984 was 10.76% higher than for FY 1983 and electric consumption was up 6.59% over FY 1983.

### 1.3 SPECIAL INSTRUCTIONS

Since the scope of work was written for a base-wide study and this study includes only a few buildings at the base, some items were deleted from the scope of work. This includes:

- (i) Paragraph 2.5 Future Population
- (ii) Paragraph 6.2.4 Information on Meters
- (iii) Paragraph 6.3.1 Distribution Systems
- (iv) Paragraph 6.3.4 EMCS Study, which was deleted from the scope of work by the post.

It was established that three buildings will be computer modelled, using the Carrier E20-II program. These are buildings 2353, E1930 and E5185, which have the highest annual energy savings.

The "expected lives" of the buildings used for the life cycle cost analysis were obtained from the Building Information Schedules (BIS) and verified by the post.

#### 1.4 FINDINGS

The work done was performed in two phases. The first phase involved site visits and data collection on the various buildings. The data collected included drawings and building information schedule (BIS). Site visits were performed to collect information on cooling and heating equipment, lighting type, lighting levels, operating schedules and function of the building. Conversations and interviews were conducted with the building administrators to gain an insight into the operation of the building and to help in identifying energy conservation opportunities (ECO's). All information collected was used to identify the various ECO's applicable. The second phase involved evaluation of the various energy conservation opportunities and life cycle cost analysis.

A list of Energy Conservation Opportunities (ECO's) to be investigated is contained in Table 1-1. This list along with previous energy conservation retrofit experience, and observations and data obtained from site visits provided a basis for a list of ECO's to be quantitatively analyzed. The opportunities involved are:

- Wall Insulation
- Window Weatheriztion
- Weatherstripping
- Upgrading EMCS
- Infrared Heaters
- Destratification
- Return Condensate
- Reduce Lighting Levels
- High Efficiency Lighting

- Improve Power Factor
- Revise/Repair HVAC Controls
- Low Leakage Rolling Doors
- Light Motion Sensors
- Centralized Chiller Plant
- Expand EMCS to Include Night Setback

After analysis of the above ECO's, life cycle cost analysis was performed to calculate their SIR values. Tables 1.2 and 1.3 summarize the results of the ECO's evaluated for the Aberdeen and Edgewood areas. Projects having SIR value less than 1.2 are not recommended per directions from the post. The tables show the total savings for projects having SIR greater than 1 and 1.2.

ENERGY CONSERVATION OPPORTUNITIES

Building Envelope

Wall Insulation

Roof/Ceiling Insulation

Storm Windows/Double Glazing

Weatherstripping/Double Glazing

Reduces Glass Area

Insulation Panels

Vestibules

Low Leaks Rolling Doors

Plastic Strip Doors

Air Curtains

Night-Red Stack

Desirable Heaters

Decentralization

Boiler Trim Controls

Reserve Boiler Controls

Insulate Steam Lines

DHW Heat Exchangers

Return Condensate

Shutdown Hot Water Heater

Shower Flow Restrictor

Shutdown Hot Water Heater

**Location: Aberdeen Proving Grounds,  
Edgewood Area**

TABLE 1.1 ENERGY CONSERVATION OPPORTUNITIES MATRIX

## ENERGY CONSERVATION OPPORTUNITIES

Lighting and Electrical  
Air-Conditioning

Misc.

5

111

51

三

111

100

Implemented by Post

1

**Legend**

- Retrofit to be Investigated by WESTON
- ▲ Retrofit Implemented or Being Implemented by Post
- Retrofit Investigated by WESTON for Boiler Plant/Chiller Plant Study
- △ Retrofit Investigated by JRB Assoc.
- Current ECP Project

Location: Aberdeen Proving Grounds,  
Edgewood Area

ENERGY CONSERVATION OPPORTUNITIES		Building No.	Very Sensitive Area	Sentry Station	Being Renovated
Opportunity Type	Location				
Lighting and Electrical		E1930			
Air-Conditioning		E2100			
Misc.		E2101			
	Centralized CHW Plant	E3081			
	Converter to VAV System	E3100			
	DCC/Unococ. Control	E3160			
	Duty Cycled	E3220			
	Demand Limited Cycle	E3222			
	Economizer Limiting	E3226			
	High Efficiency Lighting	E3244			
	Reduce Lighting Level	E3300			
	Heat Reclaim From Hot Ref. Gas	E3550			
	High Efficiency Motor	E3580			
	FM Radio Factor	E3725			
	Optimize Ineff. Kitchen Light	E3728			
	Reduce Transformer Loss	E5100			
	Revise/Replace HVAC Controls				
	EMCS Recovery System				
	Improve Exhaust System				
	Thermal Barriers for Food Cases				

TABLE 111. (CONTINUED)

## ENERGY CONSERVATION OPPORTUNITIES

Building Envelope

TABLE 1.1 (CONTINUED)

ENERGY CONSERVATION OPPORTUNITIES		Misc.	Lighting and Electrical	Air-Conditioning	Building No.	Remarks
Category	Opportunity					
	Heat Recovery-Compressor					
	Thermal Barriers for Food Cans					
	Improve Exhaust System					
	EMCS					
	Reduce Street Light					
	Revise/Replace HVAC Controls					
	Optimize Transformer Loss					
	Replace Kitchen Light					
	FM Radio Power Factor					
	Replace Ineff. Kitchen Light					
	Improve Energy Motor					
	High Efficiency Lighting					
	Reduce Light From Hot Ref. Gas					
	Heat Recovery Cycle					
	Economical Limiting					
	Duty Cycling					
	Programmed Start/Stop					
	OCc./Unocc. Control					
	Convert to VAV System					
	Centralized CHW Plant					
	Location: Aberdeen Proving Grounds, Edgewood Area					
Legend	• Retrofit to be Investigated by WESTON					
	▲ Retrofit Implemented or Being Implemented by Post					
	■ Retrofit Investigated by WESTON for Boiler Plant/Chiller Plant Study					
	△ Retrofit Investigated by JRB Assoc.					
	E Current ECIP Project					

TABLE 1.1 (CONTINUED)



## ENERGY CONSERVATION OPPORTUNITIES

Table 1.1 (CONTINUED)

## ENERGY CONSERVATION OPPORTUNITIES

Table 1.1 (CONTINUED)

ENERGY CONSERVATION OPPORTUNITIES

Table 1.1 (CONTINUED)

**Location: Aberdeen Proving Grounds, Aberdeen Area**

**Legend**

- Retrofit Investigated by WESTON
- ▲ Retrofit Implemented or Being Implemented by Post
- Retrofit Investigated by WESTON for Boiler Plant/Chiller Plant Study
- △ Retrofit Investigated by JRB Assoc.
- E Current ECIP Project

TABLE 1-2

## SUMMARY OF EVALUATED ECO'S - ABERDEEN AREA

Opportunity	Annual Energy Savings			Annual Non-Energy Cost Savings (\$)	Unescalated Current Working Estimate (\$)	Simple Payback (Yrs)	SIR
	Electricity (MBTU)	Fuel Oil (MBTU)	Total (MBTU)				
ECO 2.1: Install Light Motion Sensors in Building 393	1,039.44	----	1,039.44	4,480	10,600	2.4	2.7
ECO 2.2: Install Thermostat and Control Valve in Bldg. 670	----	124.4	124.4	860	484	0.56	12.7
ECO 2.4: Window Weatherization (#436,670)	265.50	265.50	265.50	1,835	8,457	4.60	1.23
ECO 2.5: Insulated Low Leakage Rolling Doors	----	----	45.75	45.75	316	9,693	30.70
15 x 18 Door	----	----	45.75	45.75	316	9,693	30.70
(2) 10 x 12 Door	----	38.26	38.26	264	8,220	31.10	0.11
ECO 2.6: Infrared eaters	(No cost savings even though there is energy savings.)						

TABLE 1-2 (CONTINUED)

## SUMMARY OF EVALUATED ECO'S - ABERDEEN AREA

<u>Opportunity</u>	<u>Annual Energy Savings</u>		<u>Non-Energy Cost Savings (\$)</u>	<u>Unescalated Current Working Estimate (\$)</u>		<u>Simple Payback (Yrs)</u>	<u>SIR</u>
	<u>Electricity</u> <u>(MBTU)</u>	<u>Fuel Oil</u> <u>Total (MBTU)</u>		<u>(\$)</u>	<u>(\$)</u>		
<b>ECO 2.7: Decentralization of High Bay Areas</b>							
Building 2353:	-65.2	542.90	477.70	3,470	8,214	2.40	2.98
Building 5943:	-214.1	635.10	421.00	3,467	23,770	6.90	1.01
Building 5220:	-46.6	210.20	163.60	1,250	5,867	4.70	2.37
Building 5221:	-46.6	210.20	163.60	1,250	5,867	4.70	2.37
ECO 2.9: Centralized Chiller Plant (Building 120)	531.5	----	531.50	2,290	80,000	34.90	---
<b>ECO 2.10: Reduced Lighting Levels</b>							
Building 5220:	6.03	----	6.03	26	54	2.10	4.35
Office No. 1	6.03	----	6.03	26	54	2.10	4.35
Office No. 2	6.03	----	6.03	26	54	2.10	4.35
Building 5221:	6.03	----	6.03	26	54	2.10	4.35
Office No. 1	6.03	----	6.03	26	54	2.10	4.35
Office No. 2	6.03	----	6.03	26	54	2.10	4.35

TABLE 1-2 (CONTINUED)  
SUMMARY OF EVALUATED ECO'S - ABERDEEN AREA

Opportunity	Annual Energy Savings			Unescalated		
	Electricity (MBTU)	Fuel Oil (MBTU)	Total (MBTU)	Annual Non-Energy Cost Savings (\$)	Current Working Estimate (\$)	Simple Payback (Yrs)
ICO 2.11: Replace Incandescent with Fluorescent Lighting	71.70	----	71.70	744	1,031	1.40
ICO 2.12: Replace fluorescent with energy-saving Fluorescent	388.70	----	388.70	1,675	932	0.56
ICO 2.13: Replace incandescent with HPS lighting	65.63	----	65.63	283	1,630	5.8
Building 699	51.53	----	51.53	222	2,685	12.1
Building 700	535.64	----	535.64	2,309	9,782	4.2
Building 2353	535.64	----	535.64	539	399	0.74
ICO 2.14: Upgrade HVAC Controls in Building 393	78.0	78.0	78.0	78.0	78.0	9.65
ICO 2.15: Expand EMCS o Include Night Setback	----	1,428.35	1,428.35	9,870	3,200	0.33
Building 394	244.56	244.56	244.56	1,552	3,970	2.60
Building 4025	244.56	244.56	244.56	244.56	244.56	4.15
Totals (SIR>1.2)	2,020.84	3,104.10	5,124.94	30,221	34.30	34.30
Totals (SIR>1)	1,806.74	3,739.20	5,145.94	33,688	84,419	84,419

TABLE 1-3  
SUMMARY OF ECO'S EVALUATED - EDGEWOOD AREA

<u>Opportunity</u>	<u>Annual Energy Savings</u>		<u>Annual Savings (\$)</u>	<u>Unescalated</u>		
	<u>Electricity</u> <u>(MBTU)</u>	<u>Fuel Oil Total</u> <u>(MBTU)</u>		<u>Current Working Estimate (\$)</u>	<u>Simple Payback (Yrs)</u>	<u>SIR</u>
<b>ECO 2.1: Wall Insulation</b>						
Applied to Plastic Wall (Building E1930)	----	241.50	241.50	1,669	3,139	1.90
Applied to Clay Tile Wall (Building E1930)	----	227.90	227.90	1,575	13,526	8.60
ECO 2.2: Window Weatherization	----	1,924.40	1,924.40	13,298	61,747	4.60
ECO 2.5: Replace incandescent with Fluorescent Lighting	19.8	----	19.80	205	285	1.40
ECO 2.8: Destratification of High Bay Areas	-31.1	300.80	269.70	1,944	3,520	1.80
*ECO 2.10: Condensate Return	-338.7	13,412.40	13,073.70	91,220	714,000	7.80
ECO 2.12: Reduced Lighting Levels	71.7	----	71.70	309	518	1.70
Total (SIR>1.2 or SIR>1)	-278.3	16,107.00	15,828.70	110,220	796,735	

\*Note 1: This ECO was evaluated in an earlier study by JRB Associates. WESTON has updated numbers to utilize existing fuel costs.

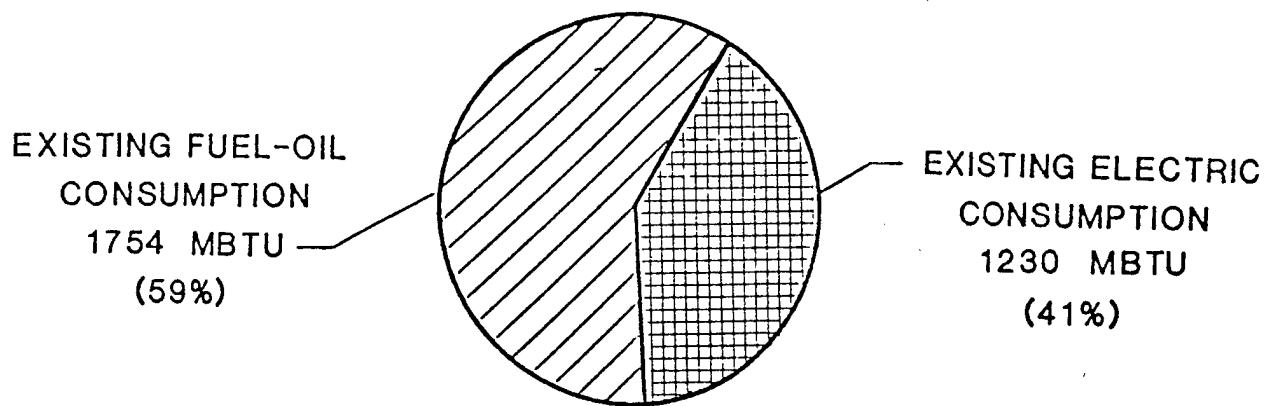
Three buildings were modelled using the Carrier E20-II operating Cost Analysis program to predict the existing annual operating costs of the buildings HVAC and non-HVAC energy consuming systems.

Comparing this with the annual energy savings per building, gives the percent energy savings for each building. The results are summarized below:

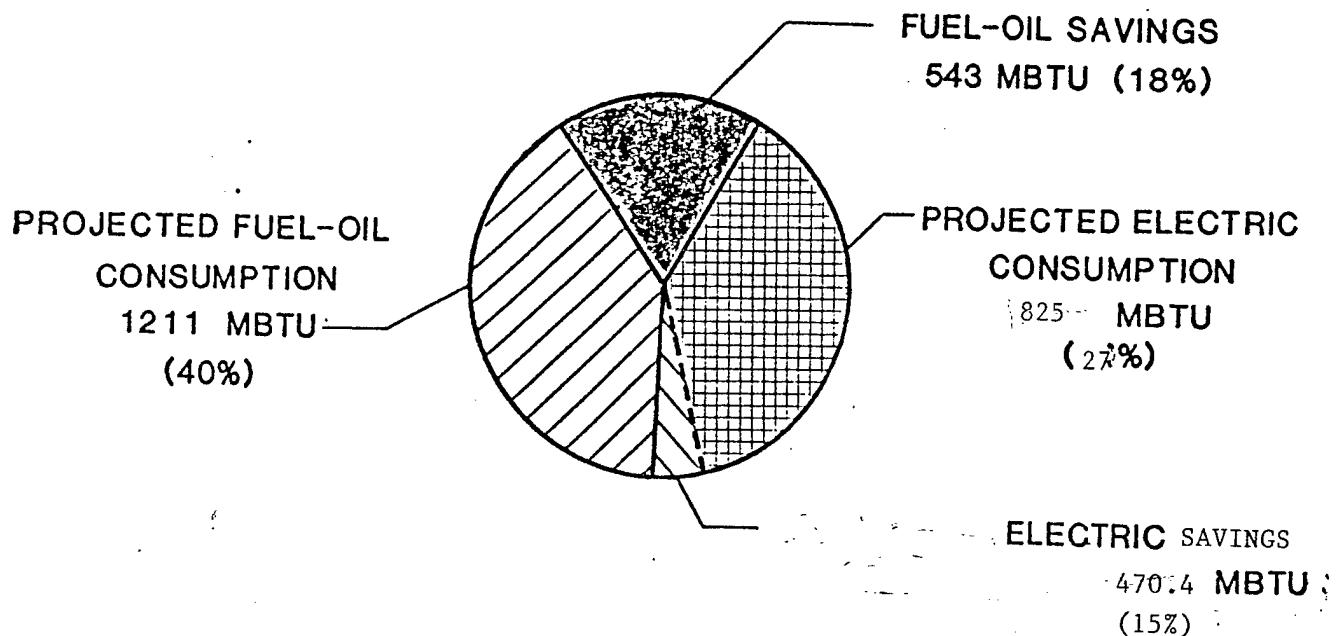
<u>Bldg. No.</u>	<u>Total Savings</u> Energy (MBTU)	<u>Cost</u> (\$)	<u>Computed</u> Annual Operating Cost (\$)	<u>Percent Cost</u> <u>Savings (%)</u>
2353	1013.3	5,779	17,417	33.2
E1930	739.1	5,188	109,229	4.7
E5185	1,924.4	13,298	83,662	15.9

Figures 1-1 through 1-3 present the existing and projected annual energy consumption for Buildings 2353, E1930 and E5185. The existing consumption figures show the percent energy used for electricity and fuel-oil. The projected consumption shows the future fuel-oil and electric consumption and savings if the recommended ECO's for that building are implemented.

FIGURE 1-1  
EXISTING AND PROJECTED ANNUAL ENERGY  
CONSUMPTION FOR BUILDING 2353  
(BASE = FY 1985)

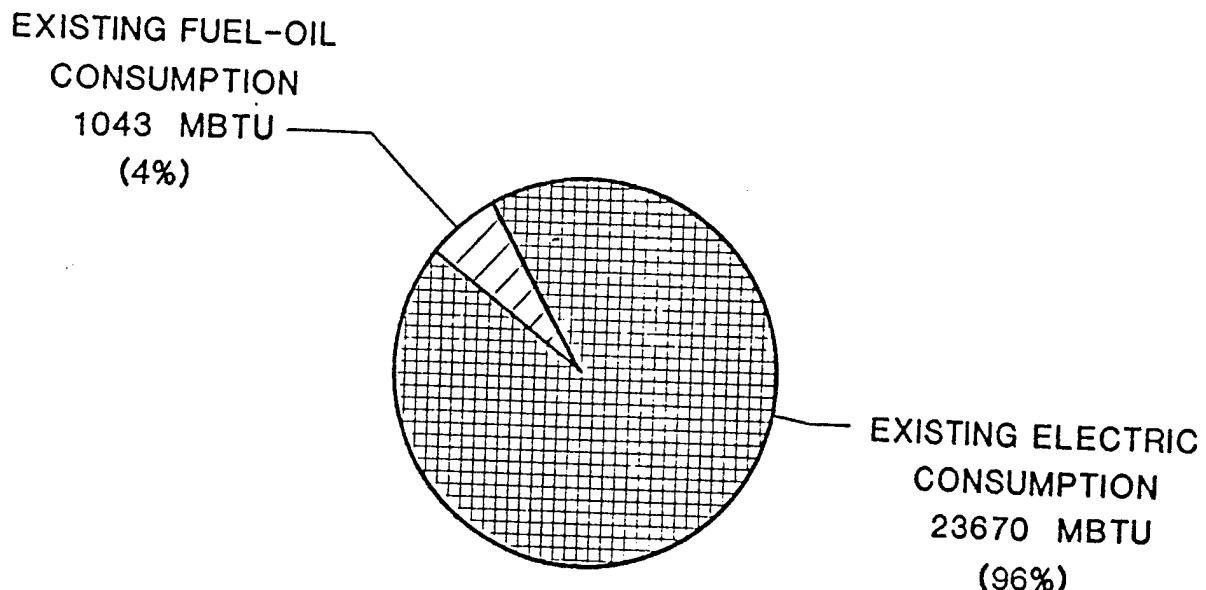


A. EXISTING

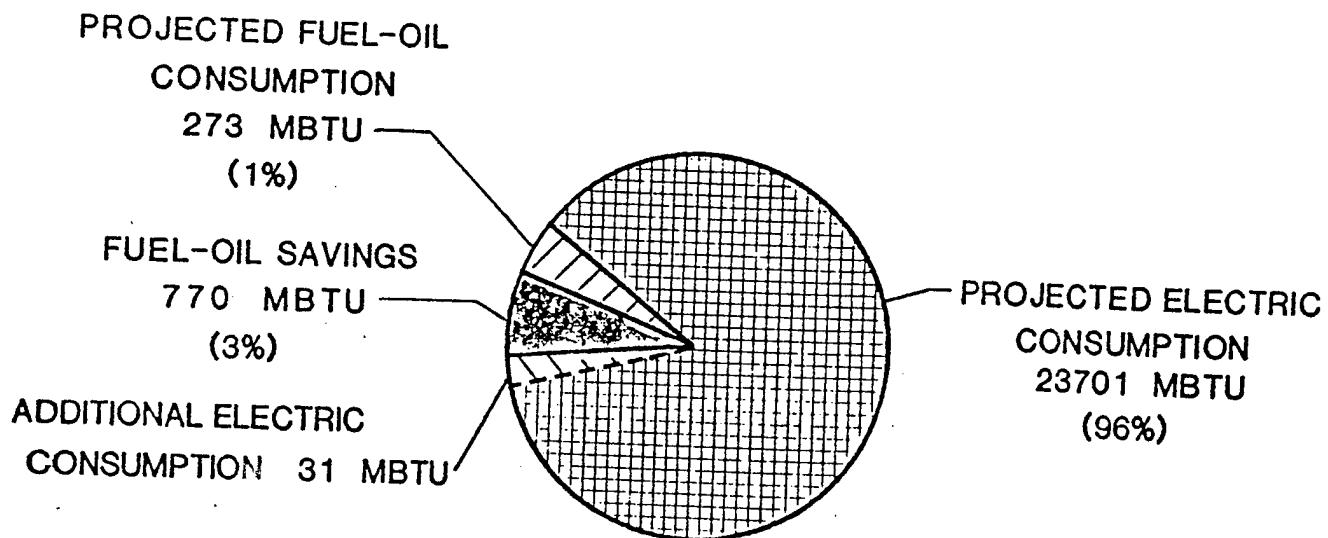


B. PROJECTED

FIGURE 1-2  
EXISTING AND PROJECTED ANNUAL ENERGY  
CONSUMPTION FOR BUILDING E1930  
(BASE = FY 1985)

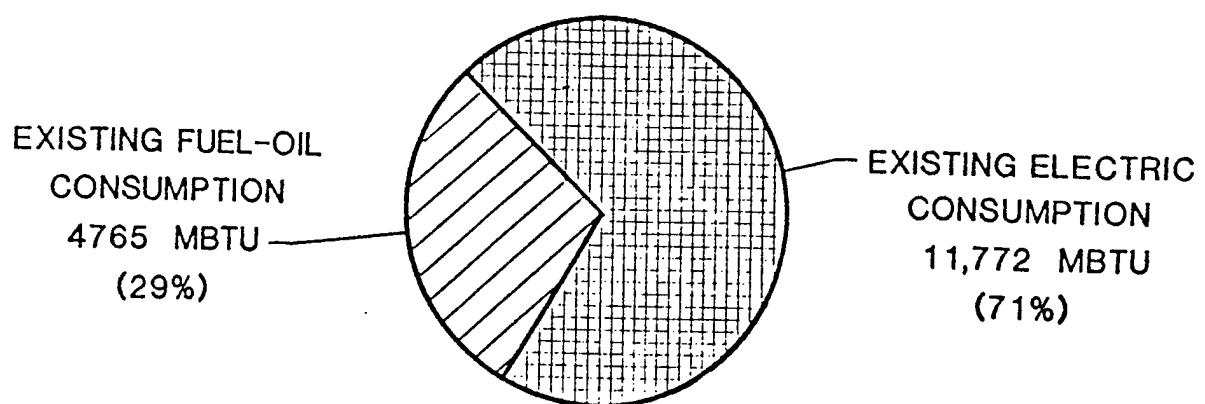


A. EXISTING

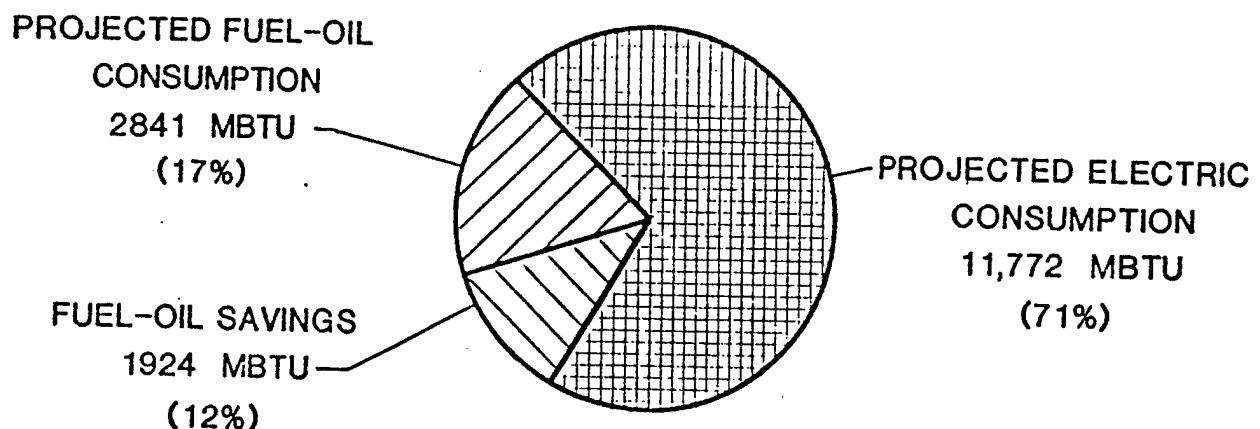


B. PROJECTED

FIGURE 1-3  
EXISTING AND PROJECTED ANNUAL ENERGY  
CONSUMPTION FOR BUILDING E5185  
(BASE = FY 1985)



A. EXISTING



B. PROJECTED

## 1.5 RECOMMENDED PROJECTS

Projects having SIR greater than 1.2 are grouped into one QRIP project, one PECIP project and one locally funded project. Two projects not included in the documentations are night setback and condensate return. Both these projects were documented as ECIP projects in an earlier study.

The projects recommended are:

PECIP Project #1: Miscellaneous building envelope and controls projects.

QRIP Project #1: Miscellaneous lighting projects.

Locally Funded Project: Wall insulation (Clay wall) - Building E1930

Table 1-4 through 1-6 summarize the PECIP, QRIP and locally funded projects. The total savings resulting from the various projects are:

- Total Annual Energy Savings = 1742.54 MBTU Electricity and 19211.1 MBTU Fuel-Oil
- Total Investment Required = \$857,384
- Total Annual Savings = \$140,441
- Simple Payback Period = 6.1 years.

TABLE 1-4

**PRECIP PROJECT 1: MISCELLANEOUS BUILDING ENVELOPE AND CONTROL PROJECTS**

TABLE 1-5

## QRIP PROJECT 1: MISCELLANEOUS LIGHTING PROJECTS

Opportunity	Annual Energy Savings			Unescalated		
	Electricity (MBTU)	Fuel Oil (MBTU)	Total (MBTU)	Annual Savings (\$)	Current Working Estimate (\$)	Simple Payback (Yrs)
reduce Lighting Levels:						
- Aberdeen (ECO 2.10)	24.12	---	24.12	104	216	2.1
- Edgewood (ECO 2.12)	71.70	---	71.70	309	518	1.7
replace Incandescent with Fluorescent Light						
- Aberdeen (ECO 2.11)	71.70	---	71.70	744	1,031	1.4
- Edgewood (ECO 2.5)	19.8	---	19.8	205	285	1.4
replace Standard Fluorescent with Energy-Saving Fluorescent						
- Aberdeen (ECO 2.12)	388.7	---	388.7	1,675	932	0.56
replace Incandescent with HPS Lighting						
- Aberdeen (ECO 2-13)	65.63	---	65.63	283	1,630	5.8
	535.64	---	535.64	2,309	9,782	4.2
Install Light Motion Sensors in Bldg. 393						
1,039.44	---	1,039.44	4,480	10,600	2.4	2.7
Totals						
2,216.73	---	2,216.73	10,109	25,264	2.5	

DTE/OMA QRIP Criteria: Cost < \$100,000  
Payback < 2 years

TABLE 1-6

LOCALLY FUNDED PROJECT - WALL INSULATION (CLAY WALL) FOR BUILDING E1930

<u>Opportunity</u>	<u>Annual Energy Savings</u>			<u>Annual savings (\$)</u>	<u>Current Working Estimate (\$)</u>	<u>Simple Payback (Yrs)</u>	<u>SIR</u>
	<u>Electricity (MBTU)</u>	<u>Fuel Oil (MBTU)</u>	<u>Total (MBTU)</u>				
WALL INSULATION (CLAY WALL) BUILDING E1930	227.9	227.9	455.8	1,575	13,526	8.60	1.93